THE EFFECTS OF MOOD ON SEMANTIC MEMORY FOR WORD EMOTIONAL CONTENT

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ABSTRACT

Although the effect of emotion on episodic memory has been extensively studied recently, little is known about its effects on the content of semantic memory. The present research explores how mood influences semantic memory for word emotional content. Following the induction of mood states that varied in valence and arousal, participants rated the valence and arousal of a list of words. Ratings were obtained immediately after mood induction and two days later. The positive mood induction groups rated words as more positive and more arousing than the negative groups, in both the immediate session and the delayed session, while they only rated their mood as more positive in the immediate session. Thus, mood valence affected semantic memory for word emotional content, and the effect persisted long after mood had disappeared. In addition to and independent from the mood valence effect, a time effect showed that word arousal ratings obtained in the delayed session were higher than those in the immediate session.

BIOGRAPHICAL SKETCH

Yu Fu received her B.S. in Psychology from Zhejiang University, China. Now she is working towards her Ph.D. in Human Development from Cornell University, US. Her broad research interest covers emotion and memory, affective neuroscience, psychobiology of social bonding and individual difference, and developmental behavioral neuroscience of positive emotion.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

The research of emotion and memory has encompassed both episodic memory and semantic memory systems. Episodic memory is a system responsible for remembering previous experiences organized temporally, while semantic memory is responsible for the acquisition, representation, and processing of conceptual information, including knowledge, facts, and ideas, organized conceptually (Saumier & Chertkow, 2002; Tulving, 1983; Tulving & Markowitsch, 1998). Studies of the two memory systems similarly investigate the effect of emotion in two ways – emotion as content (i.e., memory for emotional materials) and emotion as context (i.e., memory happening in mood states). When emotion is studied as content, episodic memory studies find that emotional materials are memorized differently from neutral materials (Clark-Foos & Marsh, 2008; Grider & Malmberg, 2008; Sharot & Phelps, 2004; Talmi & Moscovitch, 2004), and they induce different patterns of how people falsely remember non-presented materials (i.e., false memory) (Brainerd, Stein, Silveira, Rohenkohl & Reyna, 2008; El Sharkawy, Groth, Vetter, Beraldi & Fast, 2008). For instance, using the Deese-Roediger-McDermott (DRM) paradigm, in which participants memorize word lists each consisting of words sharing meanings with a non-present word (referred to as a critical lure), Brainerd et al. (2008) show that words from the negative lists are better recognized than neutral words, which are better recognized than positive words. This trend for true memory is also found for false memory for the critical lures. Likewise, semantic memory studies also find effects of emotion as content, showing that emotion affects the accessibility of stimuli in the

semantic memory system. For instance, using a priming paradigm, De Houwer, Hermans & Spruyt, (2001) show that when a target word (e.g., UGLY) is presented after a emotionally congruent prime word (e.g., CANCER), it is pronounced faster than when it is proceeded by an incongruent prime word (e.g., BIRTHDAY). This observation suggests that emotionally congruent primes pre-activate some conceptual aspects of targets, and thus increase their accessibility. The above episodic and semantic memory tasks have also been used to study the effect of emotion as context, by having participants perform these tasks in different mood states. In this line of studies, episodic memory research find that when participants watch an emotional video (as mood induction) shortly after they studied some materials, the materials are memorized better than when participants watch a neutral video during the same period (Nielson & Lorber, 2009; Nielson, Yee & Erickson, 2005). In addition, in certain mood states, participants falsely remember more critical lures in the DRM paradigm (Corson & Verrier, 2007; Storbeck & Clore, 2005). Semantic memory studies also have observed a mood effect: target words in the priming tasks are primed successfully by primer words only when participants are in a positive or neutral mood state but not a negative state (Storbeck & Clore, 2008).

Despite the fact that studies on semantic and episodic memory both investigate the effects of emotion in a similar fashion by using emotional materials or mood manipulation, an essential difference nevertheless exists. By measuring memory accuracy, episodic memory studies focus on how emotion influences the memory content (i.e., what is stored in the memory system). In contrast, studies of emotion and semantic memory measure the accessing speed in priming tasks and concentrate on the effects of emotion on

memory accessibility (i.e., how easily the content stored in the system can be accessed), but not on directly testing the alternation of memory content. Can emotion alter the content of semantic memory as it does to episodic memory? According to previous research, the semantic memory content is believed to be more resistant to change. For instance, successfully adding new words or word-word associations into semantic memory often requires various training tasks, repeated training trials and considerable time for training (Dagenbach, Horst & Carr, 1990; Schrijnemakers & Raaijmakers, 1997; Clay, Bowers, Davis & Hanley, 2007), while manipulations changing episodic memory can be as simple as varying task instructions (Craik & Tulving, 1975). Therefore, although emotion has been found effective in changing episodic memory content, it is still not clear whether it also affects semantic memory content. Investigating this ability of emotion to actually alter the content of semantic memory is thus the focus of the current study.

Specifically, we chose to examine if mood induction influences emotional ratings of words, for two main reasons. First, the perceived emotional content is an essential component of the meaning of a word (Osgood, Suci & Tannenbaum, 1957). Emotional words are semantically cohesive. These words are categorized together even if they have nothing in common other than their emotional content (Niedenthal & Halberstadt, 2000), and event-related potential research shows that parts of the brain electrophysiological responses elicited by emotional words are the same as those elicited by semantically related words (e.g., *absentee, academic, advisor, curriculum, …*) (Dillon, Cooper, Grent-'t-Jong, Woldorff & LaBar, 2006). Moreover, the emotional knowledge of stimulus, once activated, contributes powerfully to judgment formation of the stimulus. When facing emotionally salient stimuli,

decision makers are relatively insensitive to other important information, such as probability of the occurring of highly emotional stimuli and the cost-benefit analysis of a choice (for a review, see Rivers, Reyna & Mills, 2008). Second, exploring the effect of mood on word emotional ratings may reveal a potential mechanism by which mood influences episodic false memory. As reviewed above, both emotional words (i.e., emotion as content) and mood states (i.e., emotion as context) induce false memory for non-presented words that share meanings with presented words. The context effect on episodic false memory has been explained by the activation of different cognitive processing styles in different mood states. Namely, certain mood states are more likely than others to activate an elaborative, relational processing style that increases the chance of falsely remembering associated but non-presented words (Corson & Verrier, 2007; Storbeck & Clore, 2005). A potential mechanism not considered in this explanation is that the emotional context might influence episodic false memory through the effect of emotion as content. In other words, mood states may affect perceived emotional content of words, which in turn affect false memory. To test this possibility, what is needed therefore is a direct test of whether moods alter emotional ratings of words.

Theories and findings in the social cognition area have frequently demonstrated a mood effect on altering judgments. For instance, the “affect-as-information” theory proposes that affective cues of mood affect judgments by “serving as experiential and bodily information regarding how one feels about the object of judgment” (Clore & Huntsinger, 2007). According to this theory, people are likely to make judgments congruent with their mood states, because they may misattribute their feelings caused by mood to the object of judgment. As a classical example, people give higher ratings to their

happiness level and life satisfaction when in a positive mood than in a negative mood (Schwarz & Clore, 1983). This line of research seems to suggest that word ratings could also be altered by mood through the same mechanism. However, this previously observed mood effect might not extend to the alteration of word ratings, because whether or not mood affects judgments depends on participants' relationship to the object, such as being familiar with it or having previously judged it. According to the "affect infusion model" proposed by Forgas (1995), when people are highly familiar with an object and already have a prior judgment of it before mood induction, mood is less likely to infuse into their judgments. Since words used in memory research are often familiar and are chosen from a standard affective word norm, participants' ratings may be immune from the mood effect. Hence, whether mood induction alters the judgment of word emotional content is still an open question. Further, because the previous studies only ask people to make judgments when they are in the induced mood state, even if the mood effect was observed in such a procedure, it wouldn't be clear whether the mood effect could persist beyond the mood state and reflect an alternation of semantic memory itself. To address both issues, we asked participants to rate emotional content of familiar neutral words either immediately after mood induction or after a two-day delay. Their moods were measured in both sessions. We were particularly interested in whether participants in different mood induction groups show a mood congruent rating difference for word emotional content in the delayed session, when their moods presumably would not differ.

In examining possible mood effects on word emotional ratings, we separated the valence and arousal components of emotional experience for

both mood induction and word ratings. Valence refers to how positively or negatively a person feels about something, and arousal refers to how calming or exciting the feeling is. Both valence and arousal have been found influential in affecting episodic memory (Brainerd, Holliday, Reyna, Yang & Toglia, 2010; Grider & Malmberg, 2008), possibly through different neural pathways (Kensinger, 2004). However, in the research field of mood and judgment (which, as aforementioned, is closely related to our main topic of mood and semantic memory), although a few studies have investigated mood arousal and found its impact independent from mood valence (e.g. Paulhus & Lim, 1994), most of the previous studies nonetheless have only focused on mood valence, without controlling for arousal (for a review, see Forgas, 1995). Additionally, to our knowledge, no study has separated the valence and arousal components of the object of judgment, which may be differently influenced by mood valence and arousal. To obtain a clearer picture of how mood valence and arousal affect word valence and arousal, we factorially manipulated valence and arousal in a mood induction procedure (by having four mood conditions – positive, high arousal; positive, low arousal; negative, high arousal; and negative, low arousal) as well as in a word rating task (by having participants rate word emotional content in both valence and arousal dimensions).

The current study also explored whether mood effects on word emotional contents would be different, depending on the memory processing phases during which mood was induced. Two memory processing phases was investigated – the encoding phase and the consolidation phase. The encoding phase is a stage when the brain converts perceived information (e.g., word lists) into a form of memory representation and initially stores it in memory,

while the consolidation phase is a post-encoding stage when the newly formed memories become stable and resistant to loss (Hamann, 2001). In experiment procedures, an encoding phase is operationally defined as a period when participants study the given materials (e.g., word lists), and a consolidation phase begins when the study period is over (i.e., after the materials is taken away from the participants). Recent research shows that mood manipulation in both phases affect episodic memory, yet their influences can be different, depending on the memory phenomena examined. As an example, being in an aroused mood state during an encoding phase results in more false memory for associated but non-presented words, but doesn't influence true memory for the studied words (Corson & Verrier, 2007). In contrast, the true memory is improved by the aroused mood states induced in a consolidation phase (Nielson & Powless, 2007). Since semantic memory is very different from episodic memory, without investigation it is unknown how mood manipulation affects semantic memory in the encoding and consolidation phases. We examined this issue by having participants study two word lists, one before and one after mood induction. The list studied before the mood induction was the consolidation list because the mood state was induced in the consolidation phase of memory processing for this list. The list studied after the mood induction was the encoding list because the mood states had been induced when participant encoded the list. Mood effect for each list thus reflects its influence during the encoding phase and consolidation phase, respectively.

In sum, the current study investigated how mood affects semantic memory for words, specifically for their emotional content. We varied the valence and arousal components of both mood induction and word emotional ratings to study the effects of these two components facotrially. A mood state

was induced in either the encoding or consolidation phase to explore its effects in different memory processing phases.

CHAPTER 2

METHOD

Participants

One hundred and forty six undergraduate students participated in the study either for course credits or a $5 gift card. They were native speakers of English. Five participants' data were eliminated due to not properly following the instruction of the rating task.

Materials

Music and pictures were used together for the mood induction. Such a combination can be a successful mood manipulation technique as it occupies foreground attention as well as produces a background atmosphere (Mayer, Allen & Beauregard, 1995). For music excerpts, "The Arrival of the Queen of Sheba" from *Solomon* by Handel was used to induce positive, high arousal mood; "Jesu, Joy of Man's Desiring" from *Herz und Mund und Tat und Leben* by Bach was used to induce positive, low arousal mood; "Mars, the Bringer of War" from *The Planets* by Holst was used to induce negative, high arousal mood; and "Largo – E minor (NO. 4)" from *Op. 28 preludes* by Chopin and "Autumn - II. Adagio molto" from *The Four Seasons* by Vivaldi were combined to one excerpt to induce negative, low arousal mood. All four excerpts were effective in varying participants' mood states in a pilot study. For pictures, 160 pictures were chosen from the International Affective Picture System (IAPS) (Lang, Bradley & Cuthbert, 2005), based on their valence and arousal ratings. The valence ratings range from 1 (completely unhappy) to 9 (completely happy), as does the arousal ratings (1 = completely relaxed, 9 = completely aroused). 40 pictures were chosen for each mood induction condition (mean

valence = 6.96, mean arousal = 6.47 for positive high arousal pictures; mean valence = 6.89, mean arousal = 3.28 for positive low arousal pictures; mean valence = 2.07, mean arousal = 6.88 for negative high arousal pictures; and mean valence = 3.64, mean arousal = 3.90 for negative low arousal pictures).

A “music appreciation questionnaire” was composed to check the effectiveness of mood induction without releasing the purpose of the study. The first page and the main component of the questionnaire was a revised version of an “affect grid” (originally designed by Russell, Weiss & Mendelsohn, 1989). The “affect grid” is an 81-square matrix (9 rows X 9 columns). The horizontal dimension denotes mood valence and the vertical dimension denotes mood arousal. Participants indicated both their current mood valence and arousal simultaneously by marking an “X” in one of the squares. Besides the “affect grid”, other components were also contained in the questionnaire to create an impression that we were interested in studying music appreciation. These additional components included questions asking participants’ opinion towards the music excerpt and some questions from the absorption trait scale (Tellegen & Atkinson, 1974).

40 neutral words (mean valence = 5.02, mean arousal = 4.60) were chosen from the Affective norms for English words (ANEW) (Bradley & Lang, 1999) to test mood influence on perceived word emotional content. The rating scales used in ANEW is the same as those used in IAPS. The 40 words were randomly divided into two lists (denoted here as list A and list B) equal in valence ($F(1, 38) = .07$, $p = .79$), arousal ($F(1, 38) = .07$, $p = .80$), and frequency ($F(1, 38) = 0.00$, $p = .95$). Each participant was randomly assigned either to encode list A before mood induction and list B after mood induction, or to encode list B before mood induction and list A after. Hence across

participants the mood effects in the encoding and consolidation phases could be compared without being confounded with individual lists. Two orders were randomly generated for the presentation of each list, as well as for the later rating list (which contained all the 40 words). Each participant was further randomly assigned to one of the eight order combinations (e.g., order 1 for list A presentation, order 1 for list B presentation and order 2 for rating list). The word valence and arousal ratings were collected using the same rating scales as those used in IAPS and ANEW.

Procedure

Each participant completed the study alone in a quiet study room. After signing the consent form, a participant was given instructions to watch a power point presentation. In the presentation, participants first watched a list of 20 words presented one by one (2 secs for each word) in the center of a computer screen, followed by 40 pictures presented with music (8 secs for each picture, including 2 secs to appear, 4 secs to present, and 2 secs to disappear), which were then followed by a second list of 20 different words presented in the same way as the first list. The picture and music presentation were used to induce one of the four mood states. The procedure after the presentation differed for different participants, depending on which condition (immediate rating or delayed rating) they were randomly assigned to. Participants in the immediate rating group received instructions for a word rating task and completed the task immediately after the presentation. They then completed the “music appreciation questionnaire” and were dismissed. Two days later they came back and completed a second mood check. Participants in the delayed rating group completed the “music appreciation questionnaire” right after the presentation and were dismissed. When they

came back two days later, they received instructions and completed the word rating task, as well as a second mood check.

CHAPTER 3

RESULT

Mood check

Table 1 lists mood valence and arousal ratings in different mood induction groups and in the two sessions. For each session, 2 (valence induction: positive versus negative) X 2 (arousal induction: high arousal versus low arousal) analyses of variance (ANOVAs) were conducted for mood valence and mood arousal ratings, respectively. In the immediate session, there was a valence induction main effect for mood valence ratings ($F (1, 137) = 113.06$, $MSE = 2.53$, $p < .0001$). Participants in the positive valence induction groups (i.e., Positive, High arousal group and Positive, Low arousal group) rated their mood valence higher than those in the negative valence induction groups. In contrast, mood valence ratings were not affected by arousal induction ($F (1, 137) = 3.68$, $p > .05$). Similarly, arousal mood ratings were affected only by arousal induction ($F (1, 137) = 37.49$, $MSE = 3.27$, $p < .0001$) but not by valence induction ($F (1, 137) = 1.11$, $p > .05$). Participants in the high arousal induction groups rated their mood arousal higher than those in the low arousal induction groups. Hence, the mood manipulations were effective.

After a two-day delay, valence induction no longer affected mood valence ratings ($F (1, 137) = 0.00$, $p > .05$). But the Negative High arousal group rated their mood as more positive than the Negative, Low arousal group, resulting in an arousal induction main effect ($F (1, 137) = 4.42$, $MSE = 3.99$, $p = .04$) and an interaction between valence induction and arousal induction for mood valence ratings ($F (1, 137 = 4.26)$, $MSE = 3.99$, $p = .04$). For mood

arousal ratings, arousal induction no longer affected participants' mood arousal ($F(1, 137) = 1.83$, $p > .05$), while a valence induction main effect appeared ($F(1, 137) = 5.74$, $MSE = 3.14$, $p = .02$): positive valence induction groups gave higher arousal mood ratings than negative valence induction groups. Although there were unexpected small mood differences among groups in the delayed session, the critical finding was that the respective effects of valence and arousal induction on mood valence and mood arousal ratings didn't persist from the immediate session into the delayed session.

Table 1. *Means and standard deviations (in parentheses) of mood ratings for different mood induction groups*

	Positive High arousal	Positive Low arousal	Negative High arousal	Negative Low arousal
Immediate				
Mood Valence	6.03 (1.61)	6.33 (1.76)	2.95 (1.55)	3.68 (1.45)
Mood Arousal	5.63 (1.85)	4.00 (1.71)	6.20 (1.72)	4.08 (1.94)
Delayed				
Mood Valence	5.61 (2.06)	5.59 (1.90)	6.30 (1.92)	4.89 (2.10)
Mood Arousal	6.04 (1.63)	6.13 (1.82)	5.00 (1.95)	5.72 (1.64)

Word emotional ratings

Preliminary analysis showed that word presentation orders didn't reliably influence word ratings, nor did the encoding/consolidation contrast (ps > .05). Therefore, mood induced in the encoding phase and consolidation phase of memory processing was found to affect word emotional ratings in a similar fashion. We thus collapsed these variables together in the final analysis.

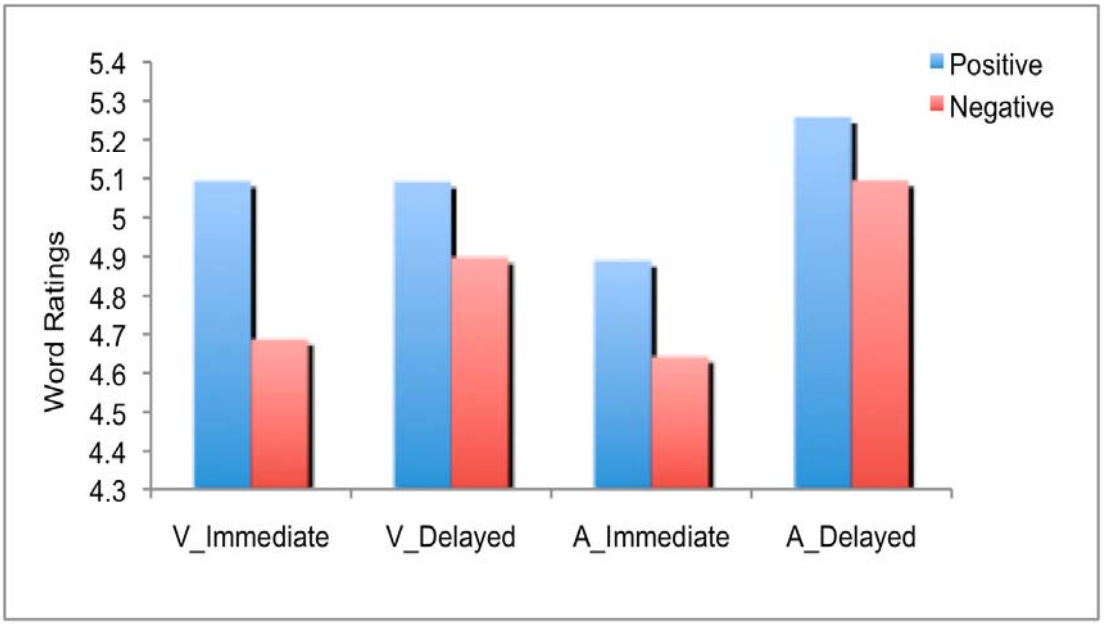

Figure 1. The influence of mood valence and time of rating on word emotional ratings. V_Immediate (A_Immediate) = word valence (arousal) ratings at the immediate session; V_Delayed (A_Delayed) = word valence (arousal) ratings at the delayed session.

A 2 (valence induction: positive versus negative) X 2 (arousal induction: high arousal versus low arousal) X 2 (time of rating: immediate versus

delayed) X 2 (rating dimensions: word valence versus word arousal) ANOVA was conducted for word emotional ratings. Results are illustrated in Figure 1. With respect to how valence and arousal induction each contributed to word emotional ratings, there was a main effect for valence ($F(1, 133) = 8.92$, $MSE = .50$, $p = .003$), but not for arousal ($F(1, 133) = .03$, $p > .05$). The positive valence induction groups gave higher ratings for word emotional content than the negative valence induction groups. Importantly, there was no interaction between valence induction and other variables ($ps > .05$). Thus, as shown in Figure 1, the positive valence induction groups not only rated word valence as more positive than the negative groups, but also rated word arousal as more arousing. Additionally, the positive valence induction groups rated the word valence and arousal higher in both immediate and delayed sessions. This result showed that the effects of mood manipulation on word emotional ratings persist from the immediate session into the delayed session.

In addition to the valence main effect, there were a time of rating main effect ($F(1, 133) = 9.305$, $MSE = .50$, $p = .003$) and an interaction between time of rating and rating dimensions ($F(1, 133) = 4.01$, $MSE = .41$, $p = .047$). As illustrated in Figure 1, the decomposition of these effects indicated that participants gave higher ratings in the delayed session than in the immediate session only for word arousal ratings ($t(122) = -3.06$, $p = .003$), but not for word valence ratings ($t(139) = -1.35$, $p > .05$).

CHAPTER 4

DISCUSSION

In this systematic investigation we explored mood effects on the content of semantic memory for word valence and arousal. Our results are consistent with the ability of mood to alter semantic memory for word emotional content. In the immediate rating session, participants in the positive groups rated their mood as more positive than those in the negative groups. Meanwhile, their word emotional ratings were higher as well. In the delayed rating session, there was no mood valence difference between the positive and negative mood induction groups; however, participants in the positive groups still gave higher ratings than those in the negative groups. Since ratings in both sessions were congruent to the mood valence ratings in the immediate session, it is likely that mood changed the semantic content of words during the immediate session and its effect persevered into the delayed session. Importantly, this persistent mood effect on word emotional ratings in the delayed session was no longer accompanied by the group difference of mood valence. This dissociation thus suggests that mood alters semantic memory for word emotional content beyond its transitory influence on judgment. Compared to previous studies illustrating difficulty in adding new words or word-word associations into semantic memory (Dagenbach, Horst & Carr, 1990; Schrijnemakers & Raaijmakers, 1997; Clay, Bowers, Davis & Hanley, 2007), the current finding implies that adding emotion into neutral words seems relevantly easy. The semantic memory for word emotional content was altered when the words were perceived in certain mood state only once, and the alteration lasted for as long as two days. Thus, although semantic memory

content is difficult to change in general, the emotional aspect of it may be an exception.

The manipulation of valence and arousal components revealed that, mood valence, but not mood arousal, affects word emotional ratings of both word valence and arousal. In other words, participants in positive mood induction groups perceived neutral word as more positive and more arousing than those in the negative mood groups. This valence effect is compatible with findings in the mood and social judgment literature that people judge congruently to their mood valence when they rate about various social objects including consumer goods, self-perception, and life satisfaction (Forgas,1995). Furthermore, our results extend previous findings in three ways. First, as mentioned above, mood valence not only informs judgment but also alters semantic memory. Second, by using normed familiar neutral words, we confirmed that even when the object of judgment is familiar, pre-rated, and as basic as single words, mood valence still reliably affects judgment. Hence, the valence congruent effect isn't restricted to judgment of complex, ambiguous social objects. Third, mood valence influences the ratings of both word valence and arousal. The underlying mechanism of this effect might involve an increase of attention devoted to the word rating task. Research has shown that positive mood promotes attention to the ongoing task (Olivers & Nieuwenhuis, 2006; Soto, Funes, Guzman-Garcia, Warbrick, Rotshtein & Humphreys, 2009) and that controlled attention is positively related to arousal level (Paus, Zatorre, Hofle, Caramanos, Gotman, Petrides et al, 1997; Novak, Hoffman & Yung, 1998). In addition, psychopharmacological evidence also suggests that positive mood, allocation of attention and heightened arousal might all be mediated by a same neurotransmitter system – the brain dopamine circuitries

(Aalto, Bruck, Laine, Nagren & Rinne, 2005; Coull, 1998). Therefore, through certain mediated pathways (such as attention), it is possible for positive mood to affect emotional content of word arousal, as observed in our results.

Similarly, attention might contribute to the time effect on word arousal ratings as well. Participants in the delayed session gave higher ratings for word arousal, compared to those in the immediate session (Fig. 1). Because the rating task was the first task in the delayed session, it is possible that this initial task recruited more attention than it did in the immediate session, where it was the second task following the mood induction. The decreased attention thus might lower the perceived word arousal. Alternatively, a "slight habituation" due to repeated exposures (Wagner, Fischer & Born, 2002) might also contribute to the time effect, because in the immediate session the rating task was right after the computer presentation where the same words were just presented. Rating words right after this mood induction presentation might contribute to lower arousal ratings also through a potential contrast effect. The presentation included music and pictorial stimuli could be more arousing than words (Keil, 2006; Kissler, Assadollahi & Herbert, 2006), so participants might perceive the words as less arousing in the immediate session than in the delayed session, where they didn't watch pictorial stimuli before the rating task. To our knowledge, the current study is the first one including word arousal ratings in testing the effect of mood on judgment and semantic memory. Thus, there is a need for future study to investigate factors that affect how people judge and memorize the arousal of stimuli. To test for possible explanations to our observation, further research integrating neuroimaging techniques, such as electroencephalography (EEG) and functional magnetic

resonance imaging (fMRI), might be especially useful in revealing which brain functions are involved in the mood and time effect, respectively.

Considering the mood effect in different phases of semantic memory processing, our results show that mood affects word emotional ratings similarly in encoding and consolidation phases. I.e., positive groups perceived word emotionality higher no matter if the words were encoded before or after mood induction. This result echoes with the findings that mood influences episodic memory in both encoding phase (for false memory) and consolidation phase (for true memory). Having said that, our results nevertheless differ from the findings in episodic memory in two ways. First, mood effects on semantic memory for word emotional contents in both encoding and consolidation phases don't differ from each other; while mood has been found to affect episodic true memory only in the consolidation phase, but not the encoding phase (Corson & Verrier, 2007; Nielson & Powless, 2007). Second, in contrast to the arousal effect reported in studies of mood and episodic memory, the effective component here was mood valence instead of arousal. Both differences might have stemmed from the dissociation between the episodic and semantic memory system, and are in general consistent with the converging evidence showing that the two memory systems are influenced differently by many factors, including age (Nilsson, Adolfsson, Backman, de Frias, Molander & Nyberg, 2004; Tulving & Markowitsch, 1998), gender (Herlitz, Nilsson & Backman, 1997), genotype (de Frias, Annerbrink, Westberg, Eriksson, Adolfsson & Nilsson, 2004), and types of amnesia (Vargha-Khadem, Gadian, Watkins, Connelly, Van Paesschen & Mishkin, 1997). In line with this evidence, mood might be another factor that has dissociating effects on episodic and semantic memory.

The current study helps to clarify the mechanism through which mood affects false memory, by exploring whether mood arousal or valence affect word emotional content. For mood arousal, we found that word emotional ratings did not change. This suggests that when mood arousal affects false memory (Corson & Verrier, 2007), the mediating factor is unlikely to be the alteration of word emotional content. In the case of mood valence, previous research using music combined with guided imagery as mood induction failed to find a mood valence effect on false memory (Corson & Verrier, 2007). Considering this finding along with our results, it's possible that the effect of mood valence on false memory may depend on the size of its influence on word emotional content. In our study, the group differences of word ratings caused by mood valence were small (valence = 5.09, arousal = 5.08, for positive groups; valence = 4.79, arousal = 4.87, for negative groups), and all ratings fell into the neutral range, operationally defined in previous studies (e.g., Grider & Malmberg, 2008). Perhaps such a small alteration in word emotional content may not be able to influence false memory, or the influence may be below the detectable range. However, because mood valence reliably alters word emotional content, it leaves open the possibility that in certain conditions a mood valence effect on false memory could be observed. For instance, word emotional content may be significantly altered by extremely traumatic or euphoric mood states, such that its influence on false memory would be detectable. Once observed, this influence may persist independently from mood valence, as suggested by our finding that the change in semantic memory for word emotional content is still observable even after a delay of two days.

Limitations of the current study include a lack of a baseline mood measure. Based on the previous finding that induced mood is short-lived (e.g., Isen & Gorgoglione, 1983), we assumed no mood difference among groups in the delayed session and that the mood ratings in this session might serve as a baseline measure. However, although mood valence ratings were not different between the positive and negative groups (and thus demonstrated change of semantic content beyond mood states), there were still small mood variations among different groups in this session. A baseline mood measure contained in future studies will show how much of participants' mood in immediate and delayed sessions differ from the baseline, and thus provide more information of mood changes resulting from experimental manipulation. The lack of a neutral mood group, due to the difficulty in finding appropriate neutral mood induction materials, is another limitation. We also didn't use a control group (i.e., a group without any mood induction) because different results between this group and other mood groups could have been due either to a mood difference or to other procedure differences. Without the neutral group, the observed valence effects between the positive and negative groups are not ready to be interpreted as implying a deviation between emotional and neutral mood states.

In conclusion, the present study demonstrates that being in positive or negative mood alters judgment and content of semantic memory for familiar neutral words, beyond the mood state for as long as two days. Both word valence and word arousal are changed in a mood valence congruent direction. The effects are observed when mood is induced in both the encoding and consolidation phases of memory processing. These findings provide insight into the procedure during which our semantic gist can be altered, and they

inform our understanding of relevant topics such as mood and false memory. As we frequently experience various mood states in our everyday lives, and we rely on semantic memory to construct daily experience, the current results may have broad implications in areas where mood and semantic memory play a role.

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